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DECLARATION

I, Thomas J. Snow, declare that I am familiar with the German language and the English language and that the attached translation is, to the best of my knowledge and belief, a true and accurate rendition into the English language of the original patent application documents (Specification and Claims) written in the German language.

The undersigned declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing therefrom.

Thomas J Snow

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May 4, 2001

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METHOD OF MANUFACTURING PISTONS AND COMPONENTS THEREOF, AND FORGING TOOL

The present invention concerns a method of manufacturing pistons and components thereof, piston heads for example, especially intended for internal-combustion engines.

German A 3 801 847 discloses a method of manufacturing pistons for internal-combustion engines, each piston being provided with at least one metal reinforcement. The reinforcement, of a material with open pores, is heated and introduced into a heated die. A prescribed amount of aluminum or aluminum alloy is injected into the die. A plunger is introduced into the die, compressing the cooling melt. The compressed melt flows around the reinforcement and fills both the piston mold and the reinforcement's pores. Once the melt has hardened, the piston is removed from the die along with the reinforcement and machine finished.

A piston especially intended for internal-combustion engines is known from German A 19 935 410. This piston features a shaft with a bore for a bolt and an adjacent annular field. Webs extend from the bore toward the annular field and/or toward the end of the shaft remote from the field. Pistons of this type are preferably cast.

German A 3 222 582 describes a method of manufacturing a base for a multiple-component piston, especially intended for large diesel engines. The center of the base is domed and surrounded by a shoulder and has an interior hub. The shoulder accommodates piston rings and rests against a separate piston shaft, onto which the hub can be screwed and/or welded. In this method a bowl with an area that matches the shape of the piston's center and has a surrounding collar is in an initial shaping step forged from a heat-resistant steel. The shoulder and the hub are then in a subsequent shaping step forged out of the collar. This approach, which involves forging axially in terms of the piston's base, however, allows only contours with prescribed wall thicknesses, especially radial wall thicknesses, and the product is heavy and requires a lot of material.

The object of the present invention is a method of manufacturing pistons and components thereof, piston heads for example, whereby the easily worn-down aluminum skirts are eliminated, less material is required, and the pistons or components will be simple to manufacture with ideal wall thicknesses. Another object of the present invention is a forging tool that can be employed to easily manufacture such pistons or components of even complex designs.

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This object is attained in accordance with the present invention in a method of manufacturing pistons and components thereof, piston heads for example, especially intended for internal-combustion engines, wherein in an initial manufacturing stage a blank that will eventually constitute the piston or piston component is preliminarily forged along a prescribed axis, shaping appropriate contours, and wherein in at least one subsequent manufacturing step the preliminarily shaped piston is finally forged along at least one other axis, creating additional contours.

Advantageous further embodiments of the method in accordance with the present invention are addressed in the associated subsidiary claims herein.

The same object is also attained in accordance with the present invention in a forging tool comprising various tool parts in the vicinity of the upper and lower die halves, whereby these tool parts can be advanced within planes defined by axes toward a blank for the purpose of preliminarily and finally shaping pistons and components thereof and whereby tool parts of at least one die half are employed for preliminary forging and tool parts of at least one die half are employed for final forging.

Advantageous further embodiments of the forging tool in accordance with the present invention are addressed in the relevant subsidiary claims herein.

In a departure from the method of manufacture described in German A 3 801 847, accordingly, a steel blank, optionally a rod, that has been produced by multiple-dimensional (multiple-axis) forging in one and the same forging tool can be employed in accordance with the present invention. Aluminum skirts like those employed in the prior art are [illegible] mutually perpendicular. When the shape is more complex, however, the blank could conceivably also be forged over at least one other plane at an angle to the aforesaid two axes.

This approach to the manufacture of a multiple-axis piston or component thereof by forging solves, as hereintofore mentioned, the problem of premature wear on the part of the aluminum skirt typical of conventional configurations in that the piston's or component's positioning skirt is steel and integrated into the overall product. German A 322 582 in no way intimates such a procedure. Furthermore, multiple-axis

forging of a blank, optionally a rod, can also produce filigreed contours, which has been possible heretofore only by casting, while consuming very little material.

The present invention will now be specified with reference to the accompanying drawing, wherein

Figure 1 is a sketch illustrating the principle involved in manufacturing piston heads,

Figure 2 is a sketch illustrating a forging tool in accordance with the present invention in principle,

and

Figure 3 illustrates a piston head forged in accordance with the method illustrated in Figure 1 in the forging tool illustrated in Figure 2.

Figure 1 shows the steps involved in manufacturing a piston head. A bar-shaped steel blank 1 is heated by induction for example and upset in a die in axis 1'. The die can be preliminarily heated if necessary. A cavity 2 is shaped out of the blank in the same die and in the same direction, and a

radial zone 3 similarly produced. First structures 5 are simultaneously shaped onto the upper face 4 of the blank. Sides 6 are then shaped in, and the inner surface of cavity 2 optimized. Sides 6 correspond to the outer diameter of cavity 2. The preliminarily shaped piston 7 is then freed of excess material 8. Since all the operations of reshaping and shaping on hereintofore specified occur in the same axis (indicated by the arrow), the shaping of blank 1 into a preliminarily shaped piston 7 represents an initial manufacturing step A.

The preliminarily shaped piston 7 is now reshaped in the very same forging tool. In this step the facing sides 6 are radially upset, positioning them within the circumference of piston 7. Any excess material 9 is removed, a procedure that is, however, not always necessary but depends on the state of the piston.

Figure 2 is a schematic illustration of a forging tool 10 with an upper die half 11 and a lower die half 12. Forging tool 10 is represented open on the left and closed on the right of the figure. Upper die half 11 accommodates tool parts 13, 14, and 15 and lower die half 12 tool parts 16 and 17. The tool parts 16 accommodated in lower die half 12 can be displaced in the direction indicated by the arrows by hydraulic piston-and-cylinder mechanisms 18. Tool parts 13

and 16 slide over surfaces 19 and 20 in lower die half 12. In initial manufacturing step A, upper die half 11 is displaced along with its tool parts 13, 14, and 15 along the axis 1′ of lower die half 12. Tool parts 16 are in a position ready to carry out along the perpendicular the reshaping operations comprising the initial manufacturing step A represented in Figure 1. Next, piston-and-cylinder mechanism 18 displaces tool parts 16 along axis 1″, preparing them to carry out the shaping operations comprising subsequent manufacturing step B.

Figure 3 is a perspective view of a piston 7 manufactured out of blank 1 over the course of manufacturing steps A and B, with sides 6 inside circumference 21. Sides 6 will eventually be bored through to accommodate an unillustrated bolt without the use of a sleeve. This bolt will be shorter than those employed in the prior art. Skirt 22 matches the circumference 21 of piston 7, its wall is optimally thick, and it extends into the radially recessed sides 6 by way of webs 23.